

## SOME ASCARID NEMATODES FROM AUSTRALIAN MARINE FISH

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## LIST OF HOSTS AND PARASITES

- MUSTELUS ANTARCTICUS Gunth.—Port Phillip, Vict.: *Capsularia marina* (Linn.), larva; *Acanthocheilus quadridentatus* Molin.
- THYRSITES ATUN Euphr.—Port Jackson and Clarence River, N.S.W.; Derwent River, Tasml.; Apollo Bay, Vict.; Port Willunga, S. Aust.; Fremantle, W. Aust.: *Capsularia marina* (Linn.), larva.
- PLATYCEPHALUS MACRODON Ogilby—Coast of N.S.W.: *Capsularia marina* (Linn.), larva; *Contracaecum* (*Thynnascaris*) *legendrei* Dollfus, larva.
- SCIAENA ANTARCTICA Castl.—Port Willunga, S. Aust., and coast of N.S.W.: *Capsularia marina* (Linn.), larva.
- ISTIOMPAX AUSTRALIS Whitley—Port Phillip, Vict.: *Capsularia marina* (Linn.), larva.
- NIPHIAS ESTARA Phillips—Cronulla, N.S.W.: *Contracaecum* (*Thynnascaris*) *incurvum* (Rud.).
- THUNNUS MACCOYI Castl.—Off Green Cape, N.S.W., and Cape Everard, Vict.: *Contracaecum* (*Thynnascaris*) *legendrei* Dollfus. Port Willunga, S. Aust.: *Capsularia marina* (Linn.), larva.
- CORYPHAENA HIPPIURUS Linn.—Jervis Bay, N.S.W.: *Capsularia marina* (Linn.), larva.
- UPENEICHTHYS POROSUS C. & V.—St. Vincent Gulf, S. Aust.: *Contracaecum* (*Thynnascaris*) *legendrei* Dollfus, larva.

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## CONTRACAECEUM (THYNNASCARIS) LEGENDREI Dollfus

(Fig. 1)

One adult male and one adult female were taken, one from each of two specimens of *Thunnus maccoyi* collected by Dr. Serventy in October and November 1919 while on the C.S.I.R. Fisheries Research Ship, "Warreen," in waters between Merimbula and Cape Everard. Immature specimens of the same species have been taken from the tiger flathead, *Platycephalus macrodon*, from the coast of New South Wales and from *Upeneichthys porosus* from St. Vincent Gulf.

The male is 26 mm. and the female 35 mm. in length. The parts of the body agree with the description given by Dollfus (1933; 1935), with the exception of the male tail, on which we are unable to recognise as many postanal papillae as shown in his figure.

The young worms from *Platycephalus* and *Upeneichthys* have the characteristic lips and ratios of parts of the alimentary canal as in the adult, but the reproductive organs are not developed.

## CONTRACAECUM (THYNNASCARIS) INCURVUM (Rud.)

(Fig. 2)

Several males and females were taken from *Xiphias estera* at Cronulla, New South Wales. They agree closely with the description of *C. (T.) incurvum* given by Dollfus. In our male specimens there appear to be a pair of adanal and four pairs of postanal papillae. Dollfus stated that he was unable to see the exact number in his material. The species was originally recorded (Johnston 1910 b, 310) as from *Xiphias gladius*, but Whitley (1934) now regards the Australian spearfish as *X. estera* Phillips.

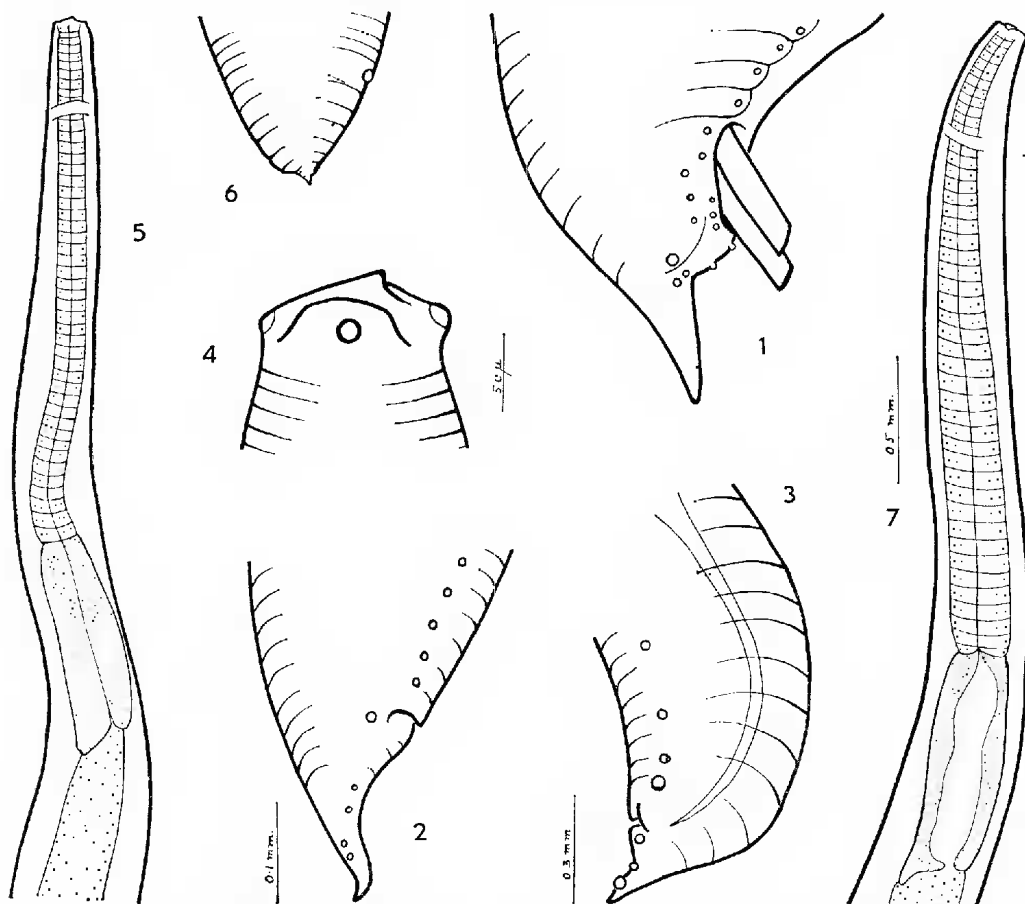


Fig. 1, *Contracaecum (Thynnascaris) legendrei*, male tail; fig. 2, *C. (T.) incurvum*, male tail; fig. 3, *Acanthocheilus quadridentatus*, male tail. Fig. 4-6—*Capsularia marina* larvae from *Thysites atun*: fig. 4, head; fig. 5, oesophageal region; fig. 6, tail. Fig. 7, *Capsularia marina*, oesophageal region of young worm from *Kogia breviceps*. Fig. 1 and 4 to same scale; 2 and 5; 5 and 7.

## ACANTHOCHAILUS QUADRIDENTATUS Molin

(Fig. 3)

A male, a female, and an immature worm were taken from *Mustelus antarcticus* from Port Phillip, and were forwarded to us by Professor Tiegs.

A description of the genus *Acanthocheilus* and the species, *A. quadridentatus*, has been given by Wülker (1930 a; 1930 b). Since the tail of his only male specimen was damaged, we are able to emend his account in this particular. There

are apparently at least nine pairs of preanal and three pairs of postanal papillae. The spicules of our 43 mm. long male are 1.1 mm. in length, but their tips are not distinct as they remain inside the worm.

A young specimen, obviously belonging to the same species, was coiled in a flat spiral. It is 21 mm. long, and its oesophagus and lips are similar to those of the adult.

The species had previously been recorded from the southern hemisphere by Baylis (1929), who gave an account of a young female from *Mustelus vulgaris* from South Africa.

#### CAPSULARIA Zeder 1800

For reasons indicated later in this paper, we consider the following genera to be synonyms of *Capsularia*: *Stomachus* Goeze 1800, *Filocapsularia* Deslongchamps 1824, *Anisakis* Duj. 1845, *Peritrachelius* Dies. 1851, and *Conocephalus* Dies. 1861. The characters are those given by Yorke and Maplestone (1926) for *Anisakis*, to which we may add—larvae spirally rolled and enclosed in rather flat disc-like capsules, present chiefly in the mesentery and subperitoneal tissues of marine fish. The subfamily term Anisakinae will require to be altered to Capsulariinae.

#### CAPSULARIA MARINA (Linn.)

(Fig. 4-7)

This widely distributed larval form has been identified by us from: (1) The barracouta, *Thyrssites atun*, from Port Willunga, South Australia; Fremantle Western Australia (coll. Professor Cleland); Apollo Bay, Victoria; Port Jackson and Clarence River, New South Wales; and Derwent River, Tasmania. (2) The tiger flathead, *Platycephalus macrodon*, from New South Wales (coll. T. C. Roughley, T. H. Johnston). (3) The mullet, jewfish or butterfish, *Sciaenops antarctica*, Port Willunga, South Australia. (4) The black marlin, *Istiompax australis*, from Mentone, Port Phillip, Victoria (coll. R. Lynn). (5) The bluefin tunny, *Thunnus maccoyi*, from Port Willunga. (6) *Coryphaena hippurus*, from Jervis Bay, New South Wales (Prof. Cleland). (7) The "gummy" shark, *Mustelus antarcticus*, Port Phillip (Prof. Tiegs). Stead's larval *Ascaris* from the viscera of *Sciaenops antarctica* from New South Wales (1914, 20) was *C. marina*.

The following account is based on material from the barracouta. The parasite was identified by Dr. Sweet (1909, 516-522) as *Ascaris marina*, her species coming from the same host species from Port Phillip, Victoria. Soon afterwards it was recorded under the same name by Johnston (1910, 711-712) who reported that masses of these spirally-coiled larvae were to be found along the whole of the mesentery of these fish (Sydney, Clarence River, Tasmania, Western Australia). Linstow (1906, 1-3) had previously described as *Ascaris sphyranurae* young worms from the body cavity of *Sphyranura barracuda* from Tasmania, sent by Jeffrey Bell, apparently from the British Museum. There has obviously been a mistake in the name of the host, as there is no fish genus *Sphyranura* but there is a genus of heterocotylean trematodes of that name. The true barracuda, a West Indian fish, is *Sphyraena barracuda*, and its ally in southern Australian waters is the snook, *Sphyraena novae-hollandiae*. Linstow's name is probably to be regarded as a lapsus for *sphyraenae*. Baylis (1916, 369) used the term *A. sphyraenae*, stating that he had examined worms from *Sphyraena* sp., the parasite being regarded as belonging to *A. capsularia*, a group name which, as we will indicate later, includes the barracouta worms. As we cannot find any other references to the specific name *sphyraenae* associated with a nematode, it seems probable that Baylis examined material (? Linstow's) from *Thyrssites*.

The term barracouta applied to our fish, *Thyrssites atun*, is due to confusion with the American fish but, though there is some similarity of form, they belong

to different families. Our barracouta occurs also in South African waters where, according to Waite (1923, 109), it is termed snoek. Gudger (1918, 81), in his paper on the West Indian barracuda, referred to Linstow's record of *Ascaris* from *Sphyrnura barracuda* from Tasmania, and suggested that the generic name was probably a mis-spelling of *Sphyracna*.

Lord and Scott (1924) do not list the snoek, *Sphyracna norachollandiae*, as occurring in Tasmania. There is thus little doubt that Linstow's material (which agrees with our own) came from *Thyrsites atun*. Linstow's record was included by Miss Young (1939, 77, 113) in her catalogue of Australian helminth parasites.

Linstow (1908, 21) also described *Ascaris thyrsitis*, a larval form from *Thyrsites atun* off South-west Africa. The account is not available to us but the parasite very probably belongs to the same species as the Australian worm. Baylis (1929, 546) grouped larval worms from *T. atun* from Tristan da Cunha, as well as from other fish from the South Atlantic, under the heading "*Porrocaecum* or *Anisakis*," but he reported that they had a ventriculus (without an appendix) and that an intestinal caecum was absent. These remarks indicate that the larvae belonged to *Anisakis*, i.e., to *Capsularia*, as also did the larva (from *Sebastes norvegicus*) which he figured in 1916 (pl. xiv, fig. 1) as that of *Porrocaecum*, to which his fig. 2 and 3 (from *Sciaena*) do belong. His figures (pl. xvi, fig. 1-2) of worms from *Clupea alosa* resemble ours so closely that we refer them to our species.

We recorded (1943) the parasite from the barracouta in southern New Zealand waters and identified it as the larval stage of *Anisakis simplex*. The mode of occurrence of the encapsuled worms is referred to by Sweet (1909, 517). Each capsule is 3-5 mm. in diameter and encloses the spirally rolled worm whose anterior end is less closely coiled than the remainder. The worms are active when released from the capsules. In one specimen the capsules formed a compact mass about 20 mm. in diameter and over 50 mm. long, surrounding the narrowed intestine of the fish.

Sweet's measurements of three individual larvae, 25, 27 and 30 mm. long respectively, indicate some degree of variability in the dimensions of the various structures. The following are our measurements in millimetres of four specimens:

	(1)	(2)	(3)	(4)
Length - - - -	18	25	27	28
Breadth - - - -	·28	·48	·48	·44
Oesoph. (muscular) - -	1·76	2·24	2·24	1·84
Ventriculus - - - -	·6	·8	·88	·76
Oesoph.: ventriculus - -	1:3	1:2·7	1:2·7	1:2·4
Head to nerve-ring - -	·28	·36	·48	·44
Tail - - - -	·1	·12	—	—

The characters of the head and tail ends are indicated in our figures. The lips are low and broad, the larval tooth prominent, and the head end narrower than the posterior.

Dr. Sweet has misinterpreted the ventriculus as an intestinal caecum, the lengths given for it by her agreeing with those mentioned by us. The ventriculus is nearly twice as wide as the muscular oesophagus and is slightly broader than that of the succeeding portion of the intestine which it enters obliquely. The posterior part of the ventriculus projects back further ventrally than it does on its dorsal side and in side view one may get the impression of a developing intestinal caecum. The difference in colour renders the ventriculus a conspicuous organ. The rather broadly rounded tail region, bearing a short, very narrow tip, is characteristic. Linstow's measurements for his *Ascaris sphyrnuræ* agree sufficiently with those given by Sweet and ourselves.

Cleland's reference (1914, 131) to *Ascaris* sp. from *Coryphaena hippurus* from Jervis Bay, New South Wales, was based on the identification by one of us (T. H. J.) of the parasites as immature nematodes resembling *Ascaris marina*. It can now be placed under *Capsularia marina*.

On the basis of the food relationship between the barracouta and dolphins, as well as of the similarity in appearance between the larvae from the former and the common ascarid, *Anisakis simplex*, of dolphins, we considered that the larva was the young stage of the latter worm and accordingly identified it as *A. simplex* in a recent paper (1943), at the same time placing *Ascaris filholi* Chatin and *A. nelsoni* Chatin (both based on similar larval worms from New Zealand or Campbell Island) under it as synonyms.

Since that paper went to press we have re-examined our cetacean nematodes and have searched literature more extensively. The smallest worm amongst our material from the pigny sperm whale, *Kogia breviceps*, was 28 mm. long, .64 mm. in maximum breadth, with a tail .12 mm. long, a muscular oesophagus 2.4 mm. and a ventriculus .8 mm. in length. The specimen agreed with the larvae from *Thyrssites* in all dimensions except breadth which had evidently increased after the worm had reached a suitable host. There is thus no doubt that "*Ascaris capsularia*" larvae are the young stages of the dolphin parasite.

Baylis (1929, 546) reported that larvae found in various fish, including *Thyrssites atun*, from the South Atlantic possessed a ventriculus, but had no caecum and that similar larvae were found in the stomach of the dolphin, *Steno rostratus*, near Cape Verde, but he did not suggest any relationship between the larvae and *Anisakis simplex*. It is of interest to note that Linstow (1880, 45) identified as *A. capsularia*, a larval form, 40 mm. long, with a boring tooth and undergoing ecdysis, found in the stomach of the porpoise, *Phocaena communis*. He stated that, since the larva was shedding its cuticle, presumably because of the presence of conditions favourable for further development, it was very probable that *A. capsularia* was the larval stage of *A. simplex*, but he had no opportunity to compare various larval measurements and characters with those of the latter.

Yamaguti (1935, 338) gave an account of a larval form occurring in numerous species of Japanese fish and identified it as *Anisakis salaris* (Gmelin), listing *Anisakis simplex* (Rud.) and *Capsularia salaris* as synonyms. His figure of the anterior end of the larva agrees with that of our own material. Yamaguti, as far as we are aware, is the only investigator who definitely associated the "*Capsularia*" type of larva with the parasite of dolphins.

*Anisakis simplex* (a term which we will use for the present) is now known to occur very widely as a parasite of the stomach of cetaceans, especially odontocetes. Its presence in the northern hemisphere has been referred to by many authors since Rudolphi named it *Ascaris simplex* in 1804 and described it in 1809, his material coming from *Phocaena*. There have been several records of the adult stage in the southern hemisphere. Krefft (1873, 212) recorded *Ascaris* sp. from *Delphinus forsteri* from New South Wales, and Cobbold (1879, 426; 1886, 177) suggested that the parasite was *Ascaris simplex*. We re-examined Krefft's specimen and reported it to be *Anisakis simplex* (1941, 433). Cobbold (1886, 177) identified the species from material collected by Darwin from a porpoise off Chiloe Island, Chili, and Monticelli (1889, 69) reported it from a dolphin from Patagonia.

Baylis (1929, 543) recorded *A. typica* from *Lagenorhynchus* off South-west Africa, and also published an account of *A. catodontis* from a sperm whale from Saldhana Bay, South Africa. The latter species appears to us to differ from *A. simplex* only in the number of papillae on the male tail, but Baylis stated that he was able to obtain only a lateral view, observing a single pair of papillae. We consider it probable that *A. catodontis* is a synonym of *A. simplex*.

We described *Anisakis kogiae* from the pigmy sperm whale, *Kogia breviceps*, from Spencer Gulf, South Australia, and from Moreton Bay, Queensland (Johnston and Mawson 1939, 263), but the detailed and emended account of *A. simplex* published by Lyster (1940) permitted us to synonymise *A. kogiae* (incorrectly indicated by Nicoll 1941, 96, as *A. kogianus*) with *A. simplex* which we also recorded from *Lagenorhynchus obscurus* from Cook Strait, New Zealand (Johnston and Mawson 1942, 183).

All records of *Anisakis simplex* have been based on cetacean material, with the exception of that by Linstow (1888) who reported *Ascaris simplex* from a seal from Kerguelen. Baylis (1916, 365) re-examined the Challenger specimens and identified them as belonging to *Porrocaecum decipiens*, a widely distributed parasite of seals. Stossich (1896), as well as Stiles and Hassall (1899), published long host lists for the adult stage, and the latter two authors also assembled in their Index Catalogue (1920) all the references to literature. Baylis (1932) brought the list up to date. Baylis (1936) has omitted reference to the presence of the parasite in Indian waters, though Dujardin (1945) recorded it as having been taken from a dolphin near the Maldivé Archipelago. Synonyms of *Anisakis simplex* are *Ascaris dussumieri* Beneden 1870; *A. angulicalvis* Creplin 1851; *A. kükenthalii* Cobb 1888; *Conocephalus typicus* Dies. 1861; *Peritrachelius typicus* (Dies.) Jägersk. 1894; and probably *Anisakis catodontis* Baylis 1929.

Dujardin (1845, 150-1) subdivided *Ascaris* (after separating off *Heterakis*) into four subgenera, *Ascaris*, *Ascaridia*, *Anisakis* and *Polydelphis*. The first had, amongst other features, two equal spicules and the oesophageal region with or without a ventricle and "pyloric appendages"; and Dujardin showed that it was possible to subdivide it on the basis of these differences in the digestive tract. These differences are the main characters which are now used to distinguish genera of the Anisakinæ. The subgenus *Anisakis* with the two species, *Ascaris distans* Rud. from monkeys and *A. simplex* from dolphins, was erected to include species whose males had two unequal spicules (as the name implies). Dujardin gave an account (p. 220) of *A. distans* based on Rudolph's description and of *A. simplex* (p. 220-221) based on material collected by Dussumier west of the Maldivé Archipelago. The oesophagus of *A. simplex* was stated to be followed by a slender curved ventricle, while that of *A. distans*, according to Rudolph, was succeeded by a spherical ventriculus. Though *A. distans* has page priority, *A. simplex* was selected subsequently as the type of *Anisakis*. *A. distans* was transferred by Railliet and Henry to *Subulura*.

Diesing (1851) did not utilise Dujardin's subgenera of *Ascaris* but he erected (1851, 209) *Peritrachelius* (type *P. insignis* from the Amazon dolphin), which is now regarded as a synonym of *Anisakis*. He also erected *Conocephalus* (1861), with *C. typicus* from a dolphin as type, and this too is synonymous with *Anisakis*.

The barracouta worms belong to the group of larval parasites to which the term *Ascaris capsularia* Rud. has been applied by various authors, more than one species having been included. Baylis (1916; 1919, 513) believed the true *A. capsularia* to be the larva of *Porrocaecum decipiens*, a widely distributed parasite of seals, but we have pointed out that he included larval *Anisakis* as well.

Linstow (1884, 127) suggested that *A. capsularia* was the larva of *Ascaris* (i.e., *Contracaecum*) *incurva*. Wülker (1939b, 14) recorded that larvae of *Anacanthocheilus* were found coiled on the viscera and under the peritoneum of marine teleosts, especially Gadidae, and were often referred to under the group names, *Ascaris capsularia* and *Filaria piscium*. This larva differs from that of *Anisakis* mainly in the modification of the dorsal portion of the oesophagus. Kahl (1938, 513) published further information regarding the larva of *Anacanthocheilus rotundatus* and its encystment, the parasite occurring as thick clusters of

spirally-rolled worms on the stomach of cod in the North Sea. The larvae of *Porrocaecum decipiens* are found especially in the musculature of fish (Kahl, 1938, 415; Wülker 1930 a; Martin 1920; Johnston and Mawson 1943), and will be considered later in connection with *Filaria piscium* and other larval forms. Encysted *Contracaecum* larvae occur curved, or more or less loosely coiled, in the subperitoneal regions of the digestive tract and coelome of marine fish. Those of *C. clavatum* (Rud., 1809) have been especially studied by Wülker 1930; Kahl 1936; and Martin 1920. Since *Ascaris clavata* was a renaming by Rudolphi of *Ascaris gadi* Mueller 1776, the name of this parasite of Gadidae should be *Contracaecum gadi* (Mueller). Linton referred frequently (1895, 1899, 1901, 1905) to various ascarid larvae in North American marine fish, his figures indicating those of *Anisakis*, *Porrocaecum* (rarely), and especially *Contracaecum*, though he usually called them *Ascaris* sp. and at times mentioned their resemblance to *A. capsularia* and *Agamonema capsularia* (1901).

Linnaeus in 1767 (Syst. Naturae, Ed. xii, p. 1075) gave the name *Gordius marinus* to worms occurring in Norwegian fish, especially in the viscera of *Clupea harecis*. In 1782 Bloch described *G. harengum*, also from a herring; Schrank in 1788, and Froelich in 1802, transferring it to *Ascaris*. Goeze (1782, 133-134) made reference to, and figured, an encapsuled spirally-rolled worm from the liver of a salmon and, though he regarded it as a new species, he did not name it. Gmelin in 1790 described *Ascaris harecis*, quoting *Gordius harengum* as a synonym, and also named *Cucullanus salaris* as a variety of *C. lacustris*, the host being the salmon (*Salmo salar*). In 1794 Fabricius transferred Gmelin's *harecis* to *Cucullanus* and gave an account of *Ascaris clupearum* (*A. harengum* Froelich).

Zeder (1800, 5-7) erected the genus *Capsularia* for the "capsule worms" of Goeze (1782) and gave a diagnosis—worms aciculate, but truncate at the ends, anterior end somewhat more slender, with a stumpy point at the tail end; digestive canal with a differentiated whitish stomach; worms enclosed in a special capsule. He included *Capsularia salaris* (based on Goeze 1782, 133, pl. viii, fig. 9-10) and *C. harecis* (based on Goeze l.c., 133; Bloch 1782; Schrank 1788). The figures of *C. harecis* (pl. i, fig. 1-6, especially fig. 4-5) indicate the same species as that from the barracouta. Zeder also referred to Goeze's remarks regarding the ventriculus, mentioning (p. 11) that Goeze had suggested the name *Stomachus albus* for the worm, on account of the "white stomach." Since *Capsularia* has page priority, *Stomachus* must be considered as a synonym.

In 1802 Rudolphi described as new species *Filaria capsularia* (syns. *Gordius harengum*, *Ascaris harecis*, *Capsularia harecis*) from the viscera of *Clupea harengus*; and *Ascaris capsularia* (syns. *Cucullanus salaris*, *Capsularia salaris*) from the salmon. We consider the two species synonymous.

In 1803 Zeder named *Ascaris trinodosa* from *Salmo salar*, but this was a renaming of *Capsularia salaris*. In 1809 Rudolphi gave an account of *Filaria capsularia* (p. 61), adding *Gordius marinus* Linn. to the synonyms mentioned above; also of *Ascaris capsularia* (p. 179) whose synonymy included *Capsularia trinodosa* in addition to those given above, the host being *Salmo salar*. He referred to Goeze's observations concerning the whitish organ behind the head region. He also mentioned (p. 203) *Ascaris clupearum* Fabricius 1794, and the account leaves no doubt that the species is the same as *A. capsularia*, though Rudolphi regarded them as distinct. His account (p. 134) of *A. constricta* suggests that it may be *A. capsularia*, as Linstow (1880, 45) and Stossich (1896) believed. Amongst the "species dubiae" Rudolphi described (1809, 74) *Filaria piscium* from several species of *Gadus* as well as from some other fish, and mentioned that Rathke in 1799 had reported it as *Filaria marina* from *Lophius* as well as from *Gadus* spp. Rudolphi stated that the parasite occurred encysted in a folded state in the muscular tissue as well as in the liver, and gave several synonyms: *Gordius*

*marinus* Linn., Houttuyn, Muller and Fabricius, in part; *Ascaris marina* Gmelin; *Fusaria marina* Zeder; and *Filaria marina* Rathke. Houttuyn's reference was to material from the liver of *Gadus* spp. The species has been listed by some authors (Creplin, Baird, Cobbold) as a synonym of *Ascaris capsularia*. Martin (1920), Kahl (1938) and others have shown that the ascarid larvae from the musculature of marine fish from northwestern European waters belong to *Porrocaecum decipiens*, and our own experience with "fleshworms" from various species of subantarctic fish (Johnston and Mawson 1943) confirms their identification.

In 1819 Rudolphi again referred to the parasites mentioned in his work of 1802—*Filaria capsularia* (p. 6) from *Clupea harengus*; *F. piscium* (p. 10, 218), *Ascaris capsularia* (p. 50) and *A. clupearum* (p. 303). He mentioned amongst "entozoa generis dubii" a number of nematodes from fish (p. 190-197, 560-567), listing them under the genitive of the generic and specific names of the host, but in the host-parasite list he indicated them as *Dubium nematoideum*, while in the index to his work they are arranged under *Dub.* (i.e., *Dubium*). Many of these parasites probably were *Contracaecum* larvae, but a number of them can be listed under *Capsularia marina*, since Rudolphi stated, when briefly describing them (p. 190-197), that they belonged to Zeder's *Capsularia*. Amongst these latter are (*Dub. nemat.*) *Syngnathi pelagici*; *Gadi wachniae*; *Zenis fabri*; *Zenis apri*; *Sparorum* (p. 564), indicated also (p. 194) as *Spari boopis*, *mormyri*, *melanuri*, *alcedinis*; *Percae cirrosae*; *Percae marinae*; and *Triglae adriaticae*. Many other ascarid larvae, such as *Ascaris argentiniae* and *A. atherinae*, were recorded by him as having been taken from the mesentery or peritoneum of marine fish, but further identification is not possible without re-examining material. Most of them are probably larvae of *Contracaecum*, though Stossich (1896) included many of them under the synonymy of *A. capsularia*.

In 1824 Deslongchamps definitely renamed *Capsularia* as *Filocapsularia* (p. 391), and his diagnosis (p. 398) included as a characteristic the rolled form of the parasite, enclosed in a disc-shaped capsule. He however stated that the worms were sometimes not rolled in a disc but were thrown into several irregular folds within the membrane. The presence of the white spot (= ventriculus) near the anterior end was noted. He reported that the parasite was found in a great number of fish belonging to different orders, genera and species. Since he failed to find any differences, except those of length, he included them all under the same name, *F. communis*, quoting as synonyms *Gordius marinus*, *G. harengum*, *Asc. marina*, *Asc. halecis*, *Asc. capsularia*, *Cucullanus salaris*, *Capsularia salaris*, *C. halecis*, *Filaria capsularia* and *F. piscium*, as well as seventeen of Rudolphi's "entozoa generis dubii," which he indicated by Rudolphi's numbers. Of these seventeen we have already mentioned eight which we consider to belong to *Capsularia*. The remainder were probably larval *Contracaecum*. From the foregoing remarks it is evident that *Filocapsularia* must fall as a synonym of *Capsularia*, and *F. communis* be accepted as a synonym (in part) of *C. marina*.

Bellingham (1844, 172) listed *Ascaris capsularia* from the peritoneum of fifteen species of fish from the Irish coast, amongst them being *Clupea harengus* (in which it was very commonly found) and *Salmo salar*. The characteristic ventriculus was referred to, as also was the presence of three very small "tubercles" around the mouth. He found that the parasite was very active and could live in fresh water for 29 days.

Dujardin (1845, 187) referred to *Ascaris capsularia*, quoting as synonyms, *Cucullanus salaris* Goeze, *Capsularia salaris* Zeder and *C. trinodosa* Zeder. He gave a list of the species of fish from which it had been recorded. His remarks concerning Bellingham's reference to the ventriculus and those made in referring to *A. culpearum* (p. 188) suggest that he had confused *Filaria piscium* (p. 205).



at least in part, with *A. capsularia*. The account of *Filaria piscium* (p. 60), for which a long host list was given by Dujardin, is that of an Anisakine worm, and the statement that there was an intestinal caecum lying beside the oesophagus indicates the larva of *Porrocaecum*. Amongst the hosts mentioned for *F. piscium* were various Gadidae, *Salmo salar* and *Clupea harengus*, and the lengthy synonymy quoted included *Gordius marinus* Linn., *G. harengum*, *Capsularia halecis* and *Filaria capsularia*. In 1840 Nordmann regarded *C. halecis* as a synonym of *Ascaris capsularia*, and in 1846 Creplin stated that *F. piscium* was a synonym of the latter. In 1849 Blanchard mentioned *Ascaris salaris* from *Gadus* and gave synonymy similar to that quoted by Dujardin for *Ascaris capsularia*.

Diesing (1851, 163) mentioned only a few hosts for *A. capsularia*, and his synonymy related chiefly to *C. salaris*. In another part of his work (p. 116-117) he dealt with *Agamonema capsularia* Dies. from numerous hosts, amongst them being *Clupea harengus* and Gadidae, his synonymy including *Gordius marinus*, *G. harengum*, *Capsularia halecis*, *Filaria capsularis* (sic) Rud., *Filocapsularia communis* Deslongchamps (*halecis*) and *Ascaris capsularia* of Bellingham. Diesing transferred *Filocapsularia communis* Deslg. (excluding *Capsularia halecis*) to *Agamonema* (p. 120), the synonymy quoted being that given by Rudolphi (1809, 74) under *Filaria piscium*, together with Rudolphi's species. The hosts mentioned are chiefly Gadidae, and the sites are liver, muscular tissue, subcutaneous tissue, peritoneum and mesentery. *Agamonema commune* (Deslg.) Dies. is probably, in part, a synonym of *Asc. capsularia*, but as described by Rudolphi (under *F. piscium*), it is quite distinct and, as we have indicated, is the larval stage of *Porrocaecum decipiens*. *Asc. clupearum* Fabr. (syn. *A. harengum* Fröl.) from *Clupea harengus* was mentioned by Diesing (1851, 204), and a reference was made under it to *Agamonema capsularia*, though he retained the species amongst sp. inquir.

Diesing mentioned, amongst others, the various nematodes of doubtful position (*Dubium nematoideum*) of Rudolphi 1819, quoting them as *Nematoideum dubium synnathi pelagici* Rud., etc. In most cases the worms were placed under *Agamonema* (pp. 118-119), sometimes with a new specific name—thus *Ag. synnathi pelagici*; *Ag. merlucci vulgaris* Dies. (syn. *Nemat. dub. gadi merluccii* Rud.); *Ag. wachniae* Dies. (syn. *Nemat. dub. gadi wachniae* Rud.) *Ag. fabri*. Dies. (syn. *Filaria zeus* (sic) *fabri* Rud. (1819, 11); *Nemat. dub. zeus fabri* Rud.); *Ag. triglae lineatae* Dies. (syn. *Dubium triglae adriaticae* Rud.); *Ag. apri* Dies. (syn. *Nemat. dub. zeus* (sic) *apri* Rud.); *Ag. sparoidum* Dies. (syn. *Nemat. dub. spari boopis, mormyri, melanuri* and *alcedinis* Rud.); *Ag. scorpaenae cirrhosae* Dies. (syn. *Nemat. dub. percae cirrhosae* (sic) Rud.; *Ag. serrani cabrillae* Dies. (syn. *Nemat. dub. percae marinae* Rud.); and *Ag. triglae lineatae* Dies. (syn. *Dubium triglae adriaticae* Rud.) *Ascaris argentinae sphyraenae* Rud. (*Asc. argentinae* Gmelin) was placed under *Nematoideum* (p. 341).

Baird (1853, 22) dealt with *A. capsularia* and gave the synonymy published by Rudolphi, as well as some later references. His material came mainly from Gadidae. He placed the species in that group of *Ascaris* spp. possessing a simple oesophagus, with or without a stomach (ventriculus), but without any pyloric appendages. He also referred to *Filaria ? marina* (p. 7), giving almost the same synonymy as that quoted by Rudolphi (1802) for *F. capsularia* and by Diesing (1851, 117) for *Agamonema capsularia*; adding *Filaria piscium* of Rudolphi, Creplin, Siebold and Dujardin, as well as *Ag. commune* Dies. (p. 106). Baird's material came from the liver of the cod and the peritoneum of *Clupea*, but his mention of the former worms being nearly straight seems to indicate that they belonged to some other species, perhaps *Contracaecum* larvae.

Siebold (1857, 26) mentioned that in many marine fishes the liver was covered with capsules, each containing a worm more than an inch long. Such

parasites were placed under *Ascaris capsularis* (sic), *Filaria piscium* and *F. cystica*. All were immature but they resembled strikingly certain adult ascarids such as *Asc. osculata*, *A. spiculigera*, etc., from seals, cormorants, gulls and predaceous fish. He suggested that the encysted worms were the larvae of some such adult ascarids.

Schneider (1862) referred to *Fil. piscium* (*Agamonema piscium*) as being a very common larval nematode found in the abdominal cavity and amongst the muscles of several species of marine fish. He stated that haddock were not eaten in Copenhagen during summer because of the abundance of these parasites in them. The oesophagus was said to have a caecal prolongation posteriorly. Probably more than one species was included under the name *F. piscium*.

In 1864 Cobbold published some synonymy of *Asc. capsularia* (1864, 406). He also mentioned (1879, 472) that sexually immature filariae were to be found in nearly every marine fish examined, and it was a very common occurrence to find the small *Filaria piscium* spirally coiled within the tissues of edible fish such as herrings, haddock, cod and whiting, all waiting passively to be transferred to their ultimate hosts, usually either fish, birds, cetaceans or seals.

Leuckart (1876) made a number of references to *F. piscium* (or *Asc. capsularia*), but he seems to have been dealing with two kinds of Ascarid larvae, viz., *A. capsularia* and another form occurring sometimes in hundreds in the flesh of marine fish. This latter is, in our opinion, the true *Fil. piscium*, i.e., the larva of *Porrocaecum decipiens*. He regarded the parasite as the young form of ascarids whose adult stage occurred in the intestine of dolphins, seals, swimming birds and predaceous fish (p. 98), the adult stages being mentioned (p. 124) as *Asc. acuta*, *A. spiculigera*, *A. osculata*, etc. In another place (p. 417, footnote), when dealing with *A. spiculigera*, he stated that the young form was *Fil. piscium*. He also used the latter term (p. 615) for the encapsuled ascarid larva occurring in the muscular part of the body ("muscle flesh") of numerous marine fish. From what we now know of larval ascarids from fish, Leuckart must have included several species (*Contracaecum*, *Porrocaecum*, *Anisakis* and perhaps others) under the term, but chiefly *Porrocaecum*.

Apart from references by Leidy (1856, 1878, 1888) little of importance relating to the species under review appeared until 1896 when Stossich's monograph on *Ascaris* appeared. In it *A. capsularia* was dealt with and a long list of fish hosts were added. Amongst its synonyms were given *A. salaris* Gmel., *A. clupearum* Fabr., *A. argentinae* Rud., *A. sciaenae* Rud., *A. ophidii-barbati* Rud., *A. ophidii-imberbis* Rud., *A. lyrae* Rud., *A. linguatulae* Rud., *A. labri-luci* Rud., *A. gadi-minuti* Rud., *A. constricta* Rud., *A. centrisci* Rud., and *A. spicrae* Dies. With reference to *A. constricta* it may be mentioned that Linstow (1880, 45) had already stated that this larval form from *Trachinus* was indistinguishable externally from *A. capsularia*. Baylis (1916, 369) placed under the latter some worms from *Cottus* and *Sciaena*, previously identified as *A. constricta*.

Monticelli in 1889 recorded *A. capsularia* from *Merlucius* from Chile, this being probably the earliest record of the larval parasite from the southern hemisphere. In 1916 Seurat recorded *Fil. capsularia*, *F. marina*, *F. piscium*, *Filocapsularia communis* and *Agamonema commune* as synonyms of *Asc. halecis* (1916, 353). In 1899 Stiles and Hassall linked up *A. capsularia* with *A. decipiens* from seals, and in 1905 designated the former (= *salaris*) as type of *Capsularia* (1905, 37, 92). In 1920 was published their Index Catalogue (Nematoda), whose references to literature have been of marked assistance in our present inquiry. In 1932 Sprehn (p. 533) referred to *Ascaris capsularis* as being probably the larva of *Porrocaecum decipiens*.

*Spiroptera hominis*, which was described by Rudolphi (1819), was placed in the synonymy of *Filaria piscium* by Schneider (1862, 275), after a re-

examination of the original material, which was reported to consist of encapsuled *F. piscium*, along with fish viscera, the specimens having been, apparently, deliberately introduced into the urethra by the patient, and thus passed in the urine. Schneider's *F. piscium* was *Asc. capsularia*. Amongst the authors accepting this synonymy for *S. hominis* were Cobbold (1864, 406-409), Leuckart (1876, 151, 395, 611), Beneden (1878), R. Blanchard (1889), and Stiles (1907). The last-named (1907, 48) included as synonyms of *Ag. piscium*, not only *Sp. hominis* but also *S. rudolphi* Chiaje 1825, *S. rudolphiana* Chiaje 1825, and *S. rudolphii* Dies, 1851. Diesing (1851, 223) had previously listed *Strongylus gigas pullus* and *Sp. rudolphii* as synonyms of *Sp. hominis*.

Many of the "species" in the Dubium group of Rudolphi (1809, 561-567) and placed by Diesing (1851) under *Agamonema* and *Nematoideum*, sometimes with new names, obtained from fish and generally encapsuled, probably belong to *A. capsularia*, as Deslongchamps (1824) and Stossich believed. Brazier (P.L.S., N.S.W., 5, 1881, 629) exhibited specimens of a *Filaria* taken in Sydney from imported salt herrings, the reference being probably to *C. marina*. Leuckart (1876, 417) suggested that *A. capsularia* was the larva of *A.* (= *Contracaecum*) *spiculigera*, while Ciurea (1921, 532) thought it was the larva of *Eustrongylides* sp. Martin (1921, 13), as well as Baylis (1916), considered it to be the larva of *Porrocaecum decipiens*, while Schwartz (1925, 6) regarded it as a group name for larval stages of *Porrocaecum* spp. Yorke and Maplestone (1926, 279) listed *Capsularia* as ? synonym of *Porrocaecum*, and *C. salaris* as a synonym of *P. decipiens*.

McIntosh (1927) mentioned the names of many fish hosts (including *Clupea* and *Salmo*) of *A. capsularia* in Scottish waters. There are various references to the presence of *A. capsularia* in Mediterranean fish—Sigalas (1923), Riccardi (1931), Cercignani (1938), Romboli (1939), Remotti (1933), and Guiart (1938). Schmidt-Ries' paper (1939) relating to the parasites of *Phocaena phocaena* is not at present available to us, nor is Mégnin's work (1882) relating to the development of *A. simplex*.

*Ascaris delphini* Rud. 1819, from the dolphin of the Ganges (*Platanista gangetica*) was indicated as *A. delphini gangetici* Lebeck ? by Diesing (1851, 155) and placed as a synonym of *A. simplex*. Cobbold (1876, 297; 1879, 426; 1886, 177), Stossich (1896), and Stiles and Hassall (1899) accepted such synonymy, but Baylis (1920, 402; 1932, 402; 1936, 87) listed it as a probable synonym of *Contracaecum lobulatum* (Schneider 1866).

Stiles and Brown (1924, 1958) gave as a character of *Capsularia* the presence of an oesophagus with a distinct ventriculus. They stated that the genus seemed to belong to the Anisakinae and might possibly supplant one of the other genera such as *Anisakis* or *Porrocaecum*.

Our survey of the literature and our examination of material from marine fish and various odontocetes indicate that *Capsularia* must replace *Anisakis* Duj., other synonyms being *Stomachus* Goeze and *Filocapsularia* Deslongchamps. The true *Ascaris capsularia* is the larval stage of the dolphin parasite commonly known as *Anisakis simplex*. *A. capsularia*, together with *Capsularia salaris* and *C. halecis* are synonyms of *Gordius marina* Linn. (in part). The correct name of the parasite is *Capsularia marina* (Linn.). The name of the subfamily Anisakinae, as emended by Baylis (1920, 260), will require to be changed to Capsulariinae, of which we regard Acanthocheilinae Wülker to be a synonym.

From Linnaeus onwards many of the earlier names (referred to above) included at least two, probably more, species. In regions where seals are frequently met with *Porrocaecum* larvae would be included. The larvae of *Contracaecum*, *Anacanthocheilus* and probably *Acanthocheilus* may also have to

be included, since, as adults, they are parasites of fish-eating vertebrates. The known distribution of *C. marina* in its larval and adult stages is now extended very considerably. Its larva is now known to occur in a great number of marine fish. In the case of the barracouta, we know that the vast assemblages that occur at times off the southern Australian coasts are preyed on by dolphins and by sharks such as the "whaler," *Carcharinus brachyurus* Gnthr. It is of interest to note that the barracouta is commonly infested with species of tetrahyhynch cestodes (Johnston, 1910, 711), whose adult stage probably occurs in such a shark.

As Baylis (1929) and Johnston (1938, 79) have pointed out, there are three main types of anisakine larvae found in marine fish. One kind is slender, without caecum or appendix, and contained in nearly flat lenticular capsules found chiefly in the subperitoneal and mesenteric tissues (*Anisakis* = *Capsularia*). The larvae of *Acanthocheilus* and *Anacanthocheilus* belong to the same general type as *Capsularia*. The second kind is larger, has an intestinal diverticulum and is usually folded in a larger capsule with one axis longer than the other, the worm being found mainly in muscular tissue (*Porrocaecum*). The third kind is variable in size and is contained in a loose capsule in which it may be merely bent or twisted or may be loosely rolled; this kind possesses an oesophageal appendix and an intestinal caecum. This last type (*Contracaecum*) occurs particularly in the mesentery, in the walls of the stomach and intestine and under the capsule or in the substance of the liver.

With the suppression of *Anisakis* the recognised species are now transferred to *Capsularia*—*C. similis* (Baird), *C. rosmari* (Baylis), *C. diomedae* (Linstow), and *C. phyteteris* (Baylis).

The synonymy of *C. marina* is now very lengthy and is quoted herewith, but no attempt is made to indicate all the literature relating to each synonym. We consider it probable that many of the synonyms recorded here may also relate, in part, to the larvae of *Acanthocheilus* and *Anacanthocheilus*, especially the latter, since Wülker (1930) reported that *A. rotundatus* was the commonest nematode occurring in German marine fish. The names marked with a query are amongst those quoted by other authors as synonyms of *A. capsularia* or some other of its many names, but the evidence available to us suggests that most of them belong, at least in part, to larval *Contracaecum* spp.

We have added a hyphen to the compound names used by Rudolphi and Diesing.

#### NAMES BASED ON THE LARVAL STAGE

*Gordius marinus* Linn. 1767 (in part); Bloch 1779; and others (in part). *G. harengum* Bloch 1782; Fabr. 1794. *Ascaris marina* Müller 1780 (in part); Gmelin 1790; Sweet 1909; Johnston 1910. *Ascaris* sp. (? *marina*) Johnston and Cleland 1914. ? *A. argentinac* Gmelin 1790; Rud. 1810, 1819; Duj. 1845. ? *A. atherinae* Rud. 1819; Duj. 1845; Dies. 1851. *A. capsularia* Rudolphi 1802, 1809, 1819; Bellingham 1844; Creplin 1846; Diesing 1851; Baird 1853; Leidy 1856; Linstow 1880; Stossich 1896; Stiles and Hassall 1899; Linton 1901; Baylis 1916 (in part). *A. capsularis* Siebold 1857; Sprehn 1932. ? *A. centrisci* Rud. 1819. *A. clupearum* Fabr. 1794; Rud. 1809, 1819; Dies. 1851. *A. constricta* Rud. 1809, 1819; Linstow 1880. *A. filholi* Chatin 1885. ? *A. gadi-minuti* Rud. 1819. *A. halecis* Gmelin 1790; Bloch 1782. ? *A. labri-lusci* Rud. 1819. ? *A. linguatulae* Rud. 1819. ? *A. lyrae* Rud. 1819. *A. nelsonis* Chatin 1885. ? *A. ophidi-barbati* Rud. 1819. ? *A. ophidi-imberbis* Rud. 1819. *A. salaris* E. Blanchard 1849. ? *A. sciaenac* Rud. 1819. *A. sphyranurac* Linstow 1906; Young 1939. *A. sphyraenac* Baylis 1916. ? *A. spicrac* Dies. 1851 (syn. *A. spari-spicrac* Rud. 1819). *A. thyrsitis* Linstow 1908. *Agamonema apri* Dies. 1851. *Ag. capsularia* Dies. 1851. *Ag. commune* Dies. 1851 (in part). *Ag. fabri* Dies. 1851.

*Ag. merlucii-vulgaris* Dies 1851. *Ag. piscium* Schneider 1862. *Ag. scorpaenae-cirrhosae* Dies. 1851. *Ag. serrani-cabrillae* Dies. 1851. *Ag. sparoidum* Dies. 1851. *Ag. syngnathi-pelagici* Dies. 1851. *Ag. triglae-lineatae* Dies. 1851. *Ag. wachniae* Dies. 1851. *Anisakis salaris* Yamaguti 1935. *An. simplex* Johnston and Mawson 1943. *Capsularia halecis* Zeder 1800. *C. salaris* Zeder 1800. *C. trinodosa* Zeder 1803. *Cucullanus halecis* Fabr. 1794. *Cuc. lacustris* v. *salaris* Gmel. 1790. *Cuc. salaris* Gmel. 1790. ?*Dubium argentine-sphyracnae* Rud. 1819. *D. gadi-merlucii* Rud. 1819. *D. gadi-wachniae* Rud. 1819. *D. percae-cirrhosae* Rud. 1819. *D. percae-marinae* Rud. 1819. *D. spari-boopis*, -*mormyri*, -*melanuri*, -*alcedinis* Rud. 1819. *D. sparorum* Rud. 1819. *D. syngnathi-pelagici* Rud. 1819. *D. triglae-adriaticae* Rud. 1819. *D. zenis-apri* Rud. 1819. *D. zenis-fabri* Rud. 1819. *Filaria capsularia* Rud. 1802, 1809, 1819; Creplin 1846. *F. capsularis* Dies. 1851 (for *F. capsularia*). *F. piscium* (in part) of authors (non. Rud. 1809). *F. zenis-fabri* Rud. 1819. *F. zenis-fabri* Dies. 1851. *Filocapsularia communis* Deslongchamps 1824 (*halecis*). *Fusaria argentine* Zeder. ?*Nematoideum argentine-sphyracnae* Dies. 1851. *N. dubium gadi-merlucii* Dies. 1851. *N. d. gadi-wachniae* Dies. 1851. *N. d. percae-cirrhosae* Dies. 1851. *N. d. percae-marinae* Dies. 1851. *N. d. spari-boopis*, -*mormyri*, -*melanuri*, -*alcedinis* Dies. 1851. *N. d. syngnathi-pelagici* Dies. 1851. *N. d. zenis-apri* Dies. 1851. *Porrocaecum* or *Anisakis* larvae Baylis 1929 (in part). *Spiroptera hominis* Rud. 1819. *Sp. rudolphi* Chiaje 1825. *Sp. rudolphiana* Chiaje 1825. *Sp. rudolphi* Dies. 1851. *Stomachus albus* Goeze in Zeder 1800. *Strongylus gigas pullus* Dies. 1851 (based on Bremser 1819).

#### NAMES BASED ON THE ADULT STAGE

*Ascaris simplex* Rud. 1809, 1819; Dujardin 1845; Diesing 1851; Cobbold 1886; Stossich 1896; Stiles and Hassall 1899, etc.: not *Ascaris simplex* Linstow 1888 (from seal, Kerguelen = *Porrocaecum decipiens*). *A. (Anisakis) simplex* Duj. 1845. *A. angulivalvis* Creplin 1851. *A. dussumieri* Beneden 1870; Stiles and Hassall 1899. *A. kükenenthalii* Cobb. 1888. *A. sp.* (from dolphin) Krefft 1873. *Anisakis catodontis* Baylis 1920. *A. dussumieri* Baylis 1920. *A. kükenenthalii* Baylis 1920. *A. kogiae* Johnston and Mawson 1939. *A. kogianus* Nicoll 1941. *A. simplex* Raill. and Henry 1912; Baylis 1920; Lyster 1940; Johnston and Mawson 1941, 1942, 1943; and other authors. *A. typica* Baylis 1920. *Conocephalus typicus* Dies. 1861. *Peritrachelius typicus* Jägersk 1894.

#### PORROCAECUM PISCIMUM (Rud. 1809), J. and M. 1943

Rudolphi (1809, 74) included amongst his doubtful species one which he named *Filaria piscium*. He gave a number of references, including Houttuyn's *Gordius marinus* Linn. (which was figured) from the liver of Gadidae. Rudolphi stated that the parasite occurred in the musculature, abdominal cavity and liver of various marine fish. He used the term "membranis implicita," suggesting that the worm was rather intricately folded within the cyst. This would imply an obvious difference from his *Filaria capsularia* and *Ascaris capsularia* described in the same work, both of these being spirally rolled within their cysts. Rudolphi mentioned as hosts for *F. piscium* three species of *Gadus*, as well as representatives of other genera, and stated that Rathke had recorded it as *Filaria marina* from *Lophius* and *Gadus* spp. In a later work, Rudolphi (1819, 218) mentioned that many kinds of entozoa had been confused by authors under the name of *F. piscium*, and since his time the latter term has been applied very commonly to larval ascarids from fish, as has been indicated earlier in the present paper. *Filocapsularia communis* Deslg. 1824 is in part a synonym of it, as also is *Agamonema commune* Dies. 1851. Diesing's list of synonyms is essentially the same as that given by Rudolphi (1809) for *F. piscium* and the main hosts mentioned are species of Gadidae. Dujardin's account of *F. piscium* (1845, 60)

indicates that he was dealing, at least in part, with a larval *Porrocaecum*. Diesing's (1851, 347) *Dubium merlucii-vulgaris* was stated to have been obtained from the abdominal muscles of *Merluccius vulgaris*. Leuckart (1876, 98, 615) referred to the presence of *F. piscium* in the muscular tissue of numerous species of marine fish. Stiles and Hassall (1899) and Baylis (1916) believed that *Ascaris capsularia* was the larval stage of *Porrocaecum decipiens*, as we have already indicated. Martin (1920) wrote concerning the ascarid larvae occurring in the flesh of North Sea fish and gave an account of the larva of *P. decipiens*; and Wülker (1930 a) returned to the same subject. Kahl (1938) gave an excellent account of the larva of *P. decipiens*, and of the process of its encapsulation in various fish. The musculature was stated to be the chief site for infestation, though the parasites were found occasionally in the walls of the viscera, such situations probably indicating the invasion route to the body muscles.

We have investigated the "flesh worms" of fish from subantarctic islands (1943) and found them to be larvae of *P. decipiens*. We also regarded *Agamonema campbelli* Chatin as a synonym. Under *Capsularia marina* we have, in passing, drawn attention to other references in literature relating to larval *Porrocaecum*.

There is no doubt that the true *Fil. piscium* Rud. (1809) is the larva of *Porrocaecum decipiens* of seals, and consequently Krabbe's specific name must be superseded by that given by Rudolphi. The chief synonyms of *P. piscium* are *Fil. piscium* Rud. 1809; Dujardin 1845; and of many authors (in part). *Dubium merlucii-vulgaris* Dies. 1851. *Ascaris decipiens* Krabbe, 1878. *Porrocaecum decipiens* Raill. and Henry 1912. *Ascaris capsularia* Baylis and others (in part). *Ascaris capsularis* Sprehn 1932. *Agamonema campbelli* Chatin. 1885.

Additional synonymy for the larva was given by Rudolphi (1809) and Diesing 1851; and for the adult by Baylis (1937) and Johnston (1938).

#### SUMMARY

- 1 *Contracaecum legendrei* Dollfus is recorded from *Thunnus maccoyi* (S.E. Australia), and its larval stage from *Platycephalus macrodon* (N.S.W.) and *Upeneichthys porosus* (S. Aust.).
- 2 *Contracaecum incurvum* (Rud.) is recorded from *Xiphias estera* (N.S.W.).
- 3 *Acanthocheilus quadridentatus* Molin is reported from *Mustelus antarcticus* (Vict.).
- 4 *Capsularia* Zeder 1800 is rehabilitated, with *Stomachus* Goeze 1800, *Filicapsularia* Deslongchamps 1824, *Anisakis* Duj. 1845, *Peritrachelius* Dies. 1851, and *Conocephalus* Dies. 1861, as synonyms, and with *C. marina* (Linn.), in part, as type.
- 5 Capsulariinae nom. nov. replaces Anisakinae; and Acanthocheilinae Wülker is a synonym.
- 6 *Capsularia marina* (L.) Johnston and Mawson is the larval stage of *Anisakis simplex*, a parasite of odontocetes, and occurs in a closely rolled condition in a flat capsule, especially in the subperitoneal tissue of the body wall and digestive tract of coastal and pelagic fish. It is now recorded from Australian fish:—*Thyrsites atun* (N.S.W., Vict., Tasm., S. Aust., W. Aust.); *Platycephalus macrodon* (N.S.W.); *Sciaena antarctica* (N.S.W., S. Aust.); *Istiompax australis* (Vict.); *Thunnus maccoyi* (S. Aust.); *Coryphaena hippurus* (N.S.W.); and *Mustelus antarcticus* (Vict.).
- 7 Extensive synonymy of *Caps. marina* is listed, more recent synonyms being *Ascaris sphyraenae* Linst., *A. thyrsitis* Linst., *Anisakis simplex* (Rud.), and *An. catodontis* Baylis.

- 8 New combinations are *Capsularia similis* (Baird), *C. rosmari* (Baylis), *C. diomedae* (Linst.), and *C. physeteris* (Baylis) for valid species previously assigned to *Anisakis*.
- 9 The correct name for *Porrocaecum decipiens* (Krabbe) appears to be *P. piscium* (Rud. 1809), *Filaria piscium* Rud. being the larval stage occurring as "flesh worms," rather loosely folded in cysts in the body musculature of marine fish.

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